



***GN Docket No. 12-354
LICENSING MODELS AND TECHNICAL
REQUIREMENTS IN THE 3550-3650 MHz BAND***

**Emerging Small Cell Technologies - Facilitating the
Development of a Spectrum Sharing Ecosystem**

17 December 2013 Ex Parte Meeting

***R. R. Miller, CTO incNETWORKS®
rrm@incnetworks.com***



AGENDA

- **A Perspective on Evolving Small Cell Technologies**
- **FCC 13-144 NPRM Licensing Model General Comments**
- **FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)**
 - *Dynamically-managed frequency assignments and automatically enforced access (SAS)*
 - *Guided cognitive radio for spectrum management and enforcement*
- **FCC 13-144 NPRM Technical Requirements for SAS Tier 2 Interference Management**
 - *Interference threshold parameters for building-level interference management*
 - *Interference threshold triggers and system segregation (at the building level)*
- ***Comments and Next Steps***

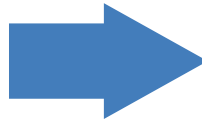
A Perspective on Evolving Small Cell Technologies

Opportunities for critical infrastructure facilities to obtain targeted priority spectrum use within specific facilities (such as a building) that meet certain requirements to mitigate the potential for interference to and from other band users

Maturation of “Small Cell Technology (1992 – 2012)”



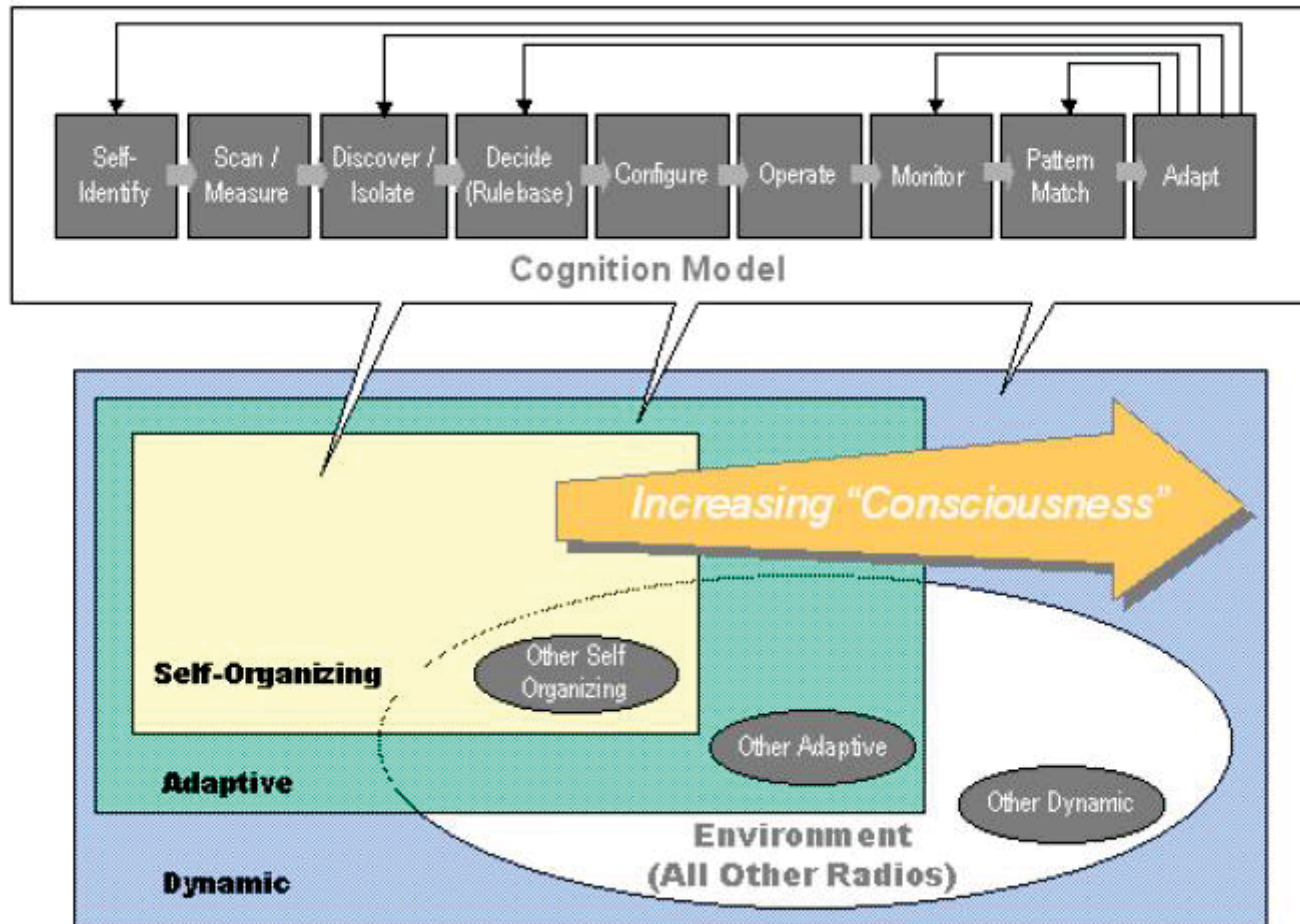
*incNETWORKS’
“Small Cell” 1998 Product*



*incNETWORKS’
“Small Cell” 2012 Product*

A Perspective on Evolving Small Cell Technologies

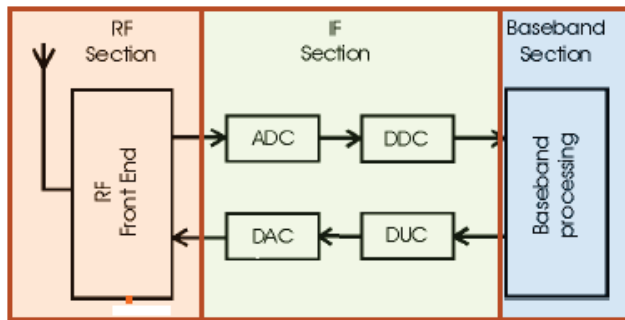
Additional GAA access to unused Priority Access bandwidth, as identified and managed by the SAS, to maximize dynamic use of the unutilized portion of the band and ensure productive use of the spectrum



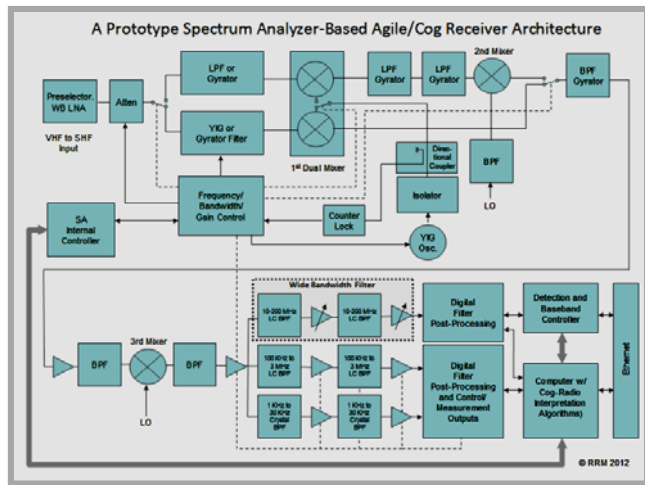
A Perspective on Evolving Small Cell Technologies

Additional GAA access to unused Priority Access bandwidth, as identified and managed by the SAS, to maximize dynamic use of the unutilized portion of the band and ensure productive use of the spectrum

Example: Infrastructure “Sniffer” with Monitor for More Dynamic Incumbent Detection Operation/Response



- A full software defined radio should be programmable in all three sections (RF/IF/Baseband)
- Current state
 - Baseband, DDC, and DUC are programmable
 - ADC and DAC – more complex
 - Programmable RF section (front end module along with tunable antennas) still at its infancy



Next State

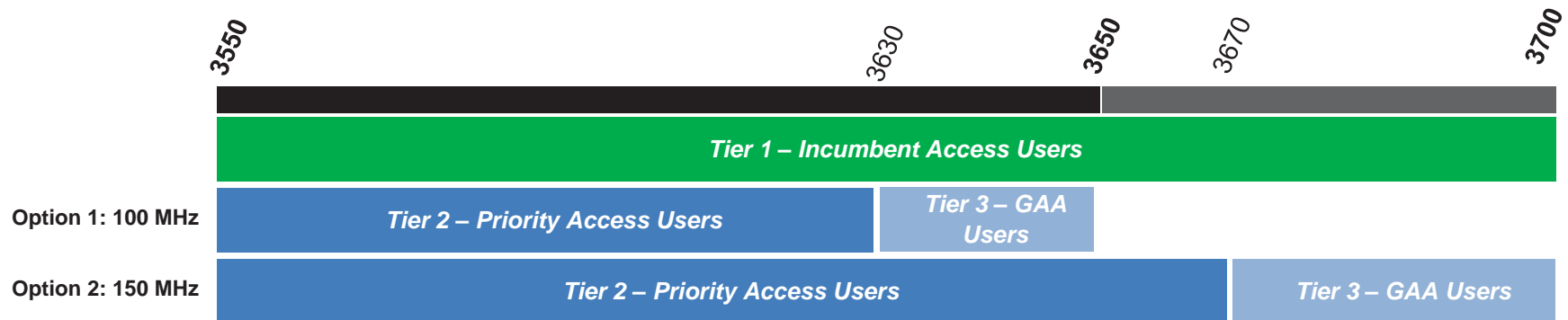
- Advanced Front-End
- TDD/FDD
- Multiple bandwidths
- Need to cooperate in common spectrum
- Must examine existing services in band
- Determine potential interference to large cell and other incumbents
- Increase responsiveness of “e-Leases”
- Use initially for small-cell APs then miniaturize for client devices to leverage volume

FCC 13-144 NPRM Licensing Model: General Comments

Open eligibility for Priority Access tier use

- Ensure that Priority Access remains separate from GAA to ensure quality and controllability by establishing separate regulatory rules
- Do not allow spectrum overlap of Priority and GAA tier services (likely to produce unreconcilable interference difficulties including dynamics of occupancy).
- Establish Priority Access for building owners to provide economically viable, non-parochial system service provider and device compatibility using non-auctioned spectrum

“Proposed Multi-Tier Framework (2 Options)”



Note:

Tiers 1 and 2 are utilize 20 MHz bands; Tier 3 = 10 MHz

Tier 2 = indoor use; Tier 3 = outdoor use



FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)

Open eligibility for Priority Access tier use

- Small-cell enterprise buildings offer an incubator for higher-quality, higher-capacity services not practical with the spectrum used today in outdoor macrocellular/microcellular use (i.e., the incubator concept could be used to assist the FCC in validating the dynamic SAS policies in a controlled, phased implementation)
- PALs can be viewed as an “industrial-strength enhancement” to unlicensed spectrum operations with security, capacity, interference management, and QoS advantages
- PALs and GAA tiers are made more powerful if integrated with current and evolving cellular end-user devices and standards
- Requires a workable dynamic SAS with database-guided and rule-based policies using Guided Cognitive Radio Concepts for PALs spectrum assignment

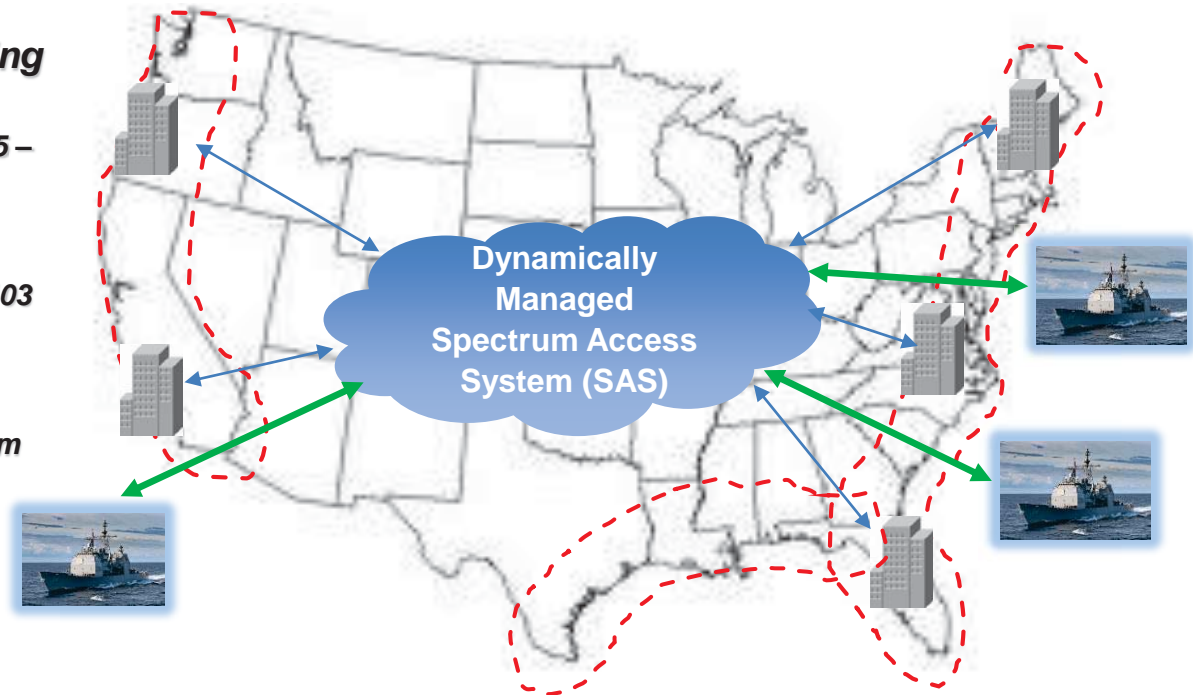
FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)

Open eligibility for Priority Access tier use

The below example demonstrates the feasibility of 3.5GHz spectrum usage within buildings that are coincident with current exclusionary zone and building technical parameters:

Key Exclusionary Zone and Building Technical Parameters:

- **Shipborne Radar A: Frequency Band 3.5 – 3.7 GHz, TX Power: 1MW, Duty Cycle: 0.001%, Antenna Gain: 32dB, Antenna Beamwidth: h/v 4.4 – 1.75 deg.**
- **1 Kilometer Distance Freespace Loss: 103 dB, Receive Avg. Power Level: -31 dBm**
- **General Building Penetration Loss Parameters: 18 dB (1 floor)**
- **Power Seen by User Equipment: -49 dBm (avg.)**



RECOMMENDATION: Given key exclusionary zone technical parameters and building loss parameters, in-building usage of 3.5 GHz for validating the spectrum sharing concept can be used as part of a phased launching approach for Tier 2 (PALs) and 3 (GAAs) to optimize FCC dynamic SAS policies.

FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)

Mutually exclusive spectrum rights for Priority Access subject to licensing by auction

- Use an “e-Lease” concept to allow smaller system operators to become competitive with larger footprint operators
- Assign spectrum in a “Micro MTA-like” framework with administrative approval as part of an SAS database transaction (see slide 12)
- Establish e-Leases for specified time periods as part of the dynamically managed SAS process
- Assignment of spectrum e-Leases based-on duration and micro-POP coverage area (i.e., building)
- e-Lease ownership is on a “first come, first served” basis assuming infrastructure build-out criteria established by the FCC, has been complied with by the e-Lease owner via successful database entry and proof of infrastructure operation

FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)

A defined “floor” of GAA spectrum availability, to ensure that GAA access is available nationwide (subject to Incumbent Access tier use)

- **Relaxed licensing: No e-Leases for GAA**
- **Recommend GAA availability similar to 5 GHz radar avoidance with respect to incumbent emission detection**
- **If presence of incumbent energy is detected by GAA base or clients, system must cease operation and move to another channel**
- **Lower GAA maximum power levels: 100 mW**

FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)

An SAS to dynamically manage frequency assignments and automatically enforce access to the Priority Access and GAA tiers)

An Example of A Guided Cognitive Radio Rule-based Concept for Dynamic SAS

United States Patent

Miller, II

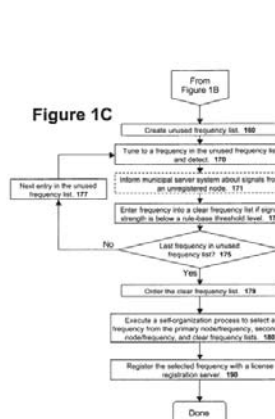
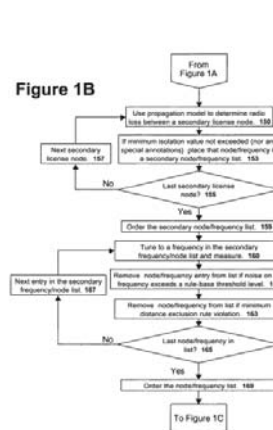
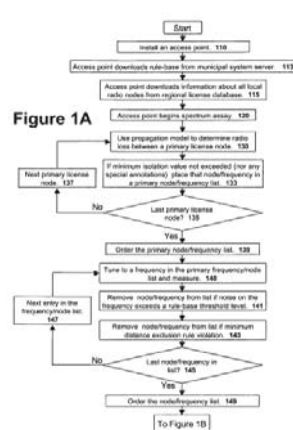
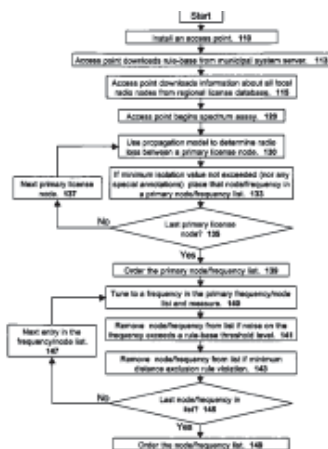
8,000,718

August 16, 2011

Spectrum management system for municipal spectrum using *guided* cognitive radio

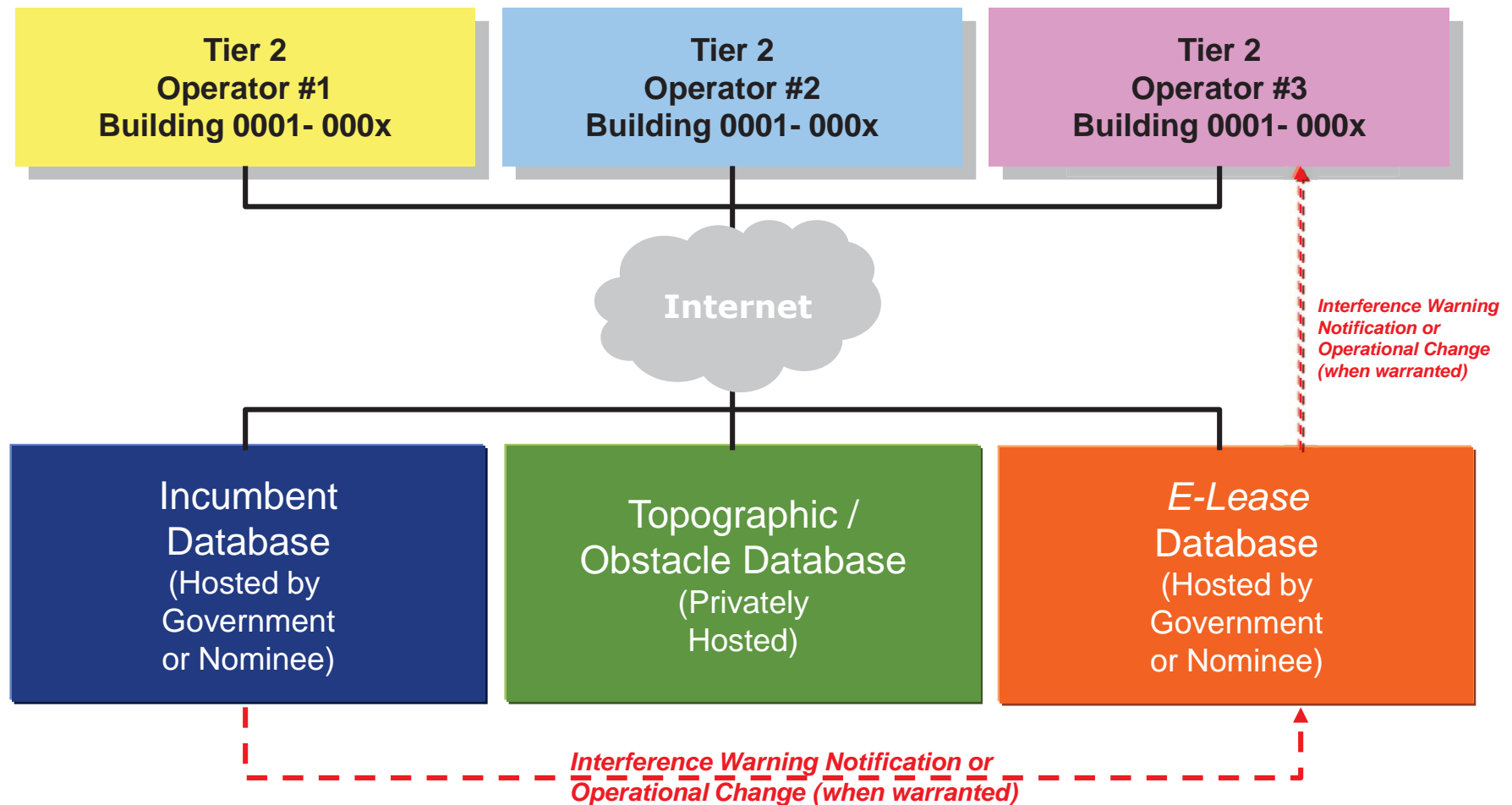
Abstract

Described is a system and method for assigning a frequency to an access point in a wireless network comprising a plurality of access points. The system and method includes accessing a rule-base to obtain a set of rules for the wireless network, accessing a license database to obtain information about relevant wireless nodes in a region, creating a list of possible primary node frequencies from a list of frequencies associated with primary wireless nodes in the license database, creating a list of possible secondary node frequencies from a list of frequencies associated with secondary wireless nodes in the license database, identifying a list of clear frequencies from a set of unused frequencies, selecting a frequency from frequencies in the lists of possible primary node frequencies, possible secondary node frequencies, and clear frequencies and registering the frequency in the license database.



FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)

An SAS to dynamically manage frequency assignments and automatically enforce access to the Priority Access and GAA tiers)



RECOMMENDATION: The utilization of parameters from multiple databases in-conjunction with a dynamic SAS can facilitate the granting of e-Leases for implementing the FCC 3.5 GHz spectrum licensing process.

FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)

Open eligibility for Priority Access tier use

- **Ensure that Priority Access remains separate from GAA to ensure quality and controllability by establishing separate regulatory rules**
- **Do not allow spectrum overlap of Priority and GAA tier services (likely to produce un-reconcilable interference difficulties including dynamics of occupancy)**
- **Establish Priority Access for building owners and critical assess users to allow economically viable small system operators to become competitive with larger footprint operators by utilizing device compatibility within non-auctioned spectrum (i.e., e-Lease spectrum)**

FCC 13-144 NPRM Architecture of Dynamically Managed SAS Tier 2 (PALs)

Granular but administratively-streamlined licensing of the Priority Access tier

- Recommend segregation of small-cell and larger-cell outdoor systems to minimize coordination / interference management) and consider designation as “small-cell band”
- Utilize LTE TDD (more flexible use of upstream/downstream resource and interference management due to reciprocity, including incumbents)
- Emulate 5 GHz power levels (proven and practical) and gives slightly better coverage / performance due to aperture advantage
- Recommend orthogonal time-sliced sharing / coordination for resolution of co-channel multi-tenant or building-building Priority or GAA tier overlap interference
- Hold some small-cell outdoor spectrum in reserve (like some 5 GHz bands) to determine if Cognitive learning shows feasibility in “substantially contained outdoor areas” (e.g. “leakage from indoors)
- Ensure that Priority Access remains separate from GAA to ensure quality and controllability by establishing a separate regulatory framework
- Establish Priority Access for building owners and critical assess users to allow economically viable small system operators to become competitive with larger footprint operators by utilizing device compatibility within non-auctioned spectrum (i.e., e-Lease spectrum)

FCC 13-144 NPRM Technical Requirements for SAS Tier 2 Interference Management

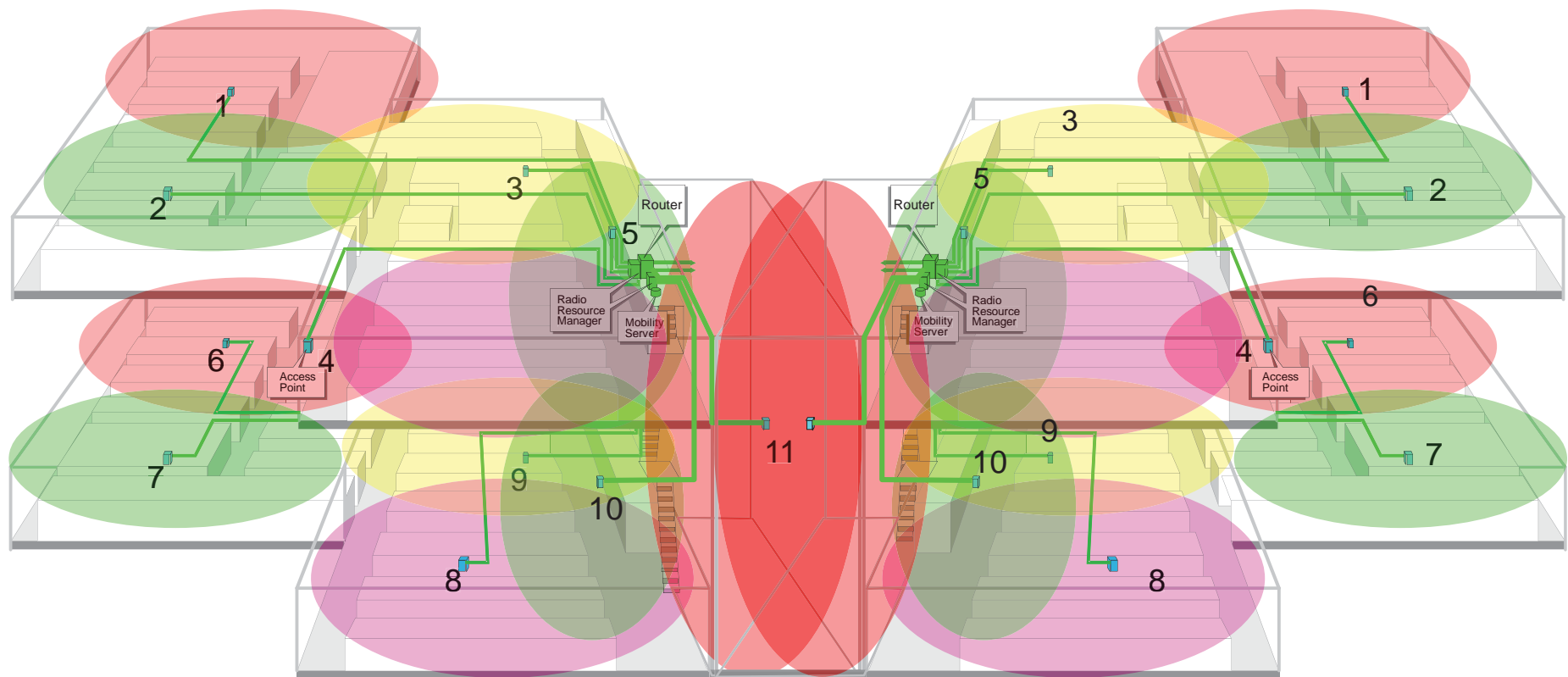
A set of baseline technical standards to prevent harmful interference and ensure productive use of the spectrum

- **Recommend orthogonal time-slicing for interference management between PAL-PAL, PAL-GAA and GAA-GAA channels**
- **Utilize fiber-Ethernet systems for synchronization of small cell systems**
- **Assumes small-cell systems have short time of flight that can utilize guard-times with minimum uncertainty**
- **Can leverage time-over-Ethernet technology for synchronization between small cell systems**

FCC 13-144 NPRM Technical Requirements for SAS Tier 2 Interference Management

An SAS to dynamically manage frequency assignments and automatically enforce access to the Priority Access and GAA tiers (4)

A Typical Enterprise Indoor/Outdoor Overlap Situation (Contribution 802.11 2007-2115r0)

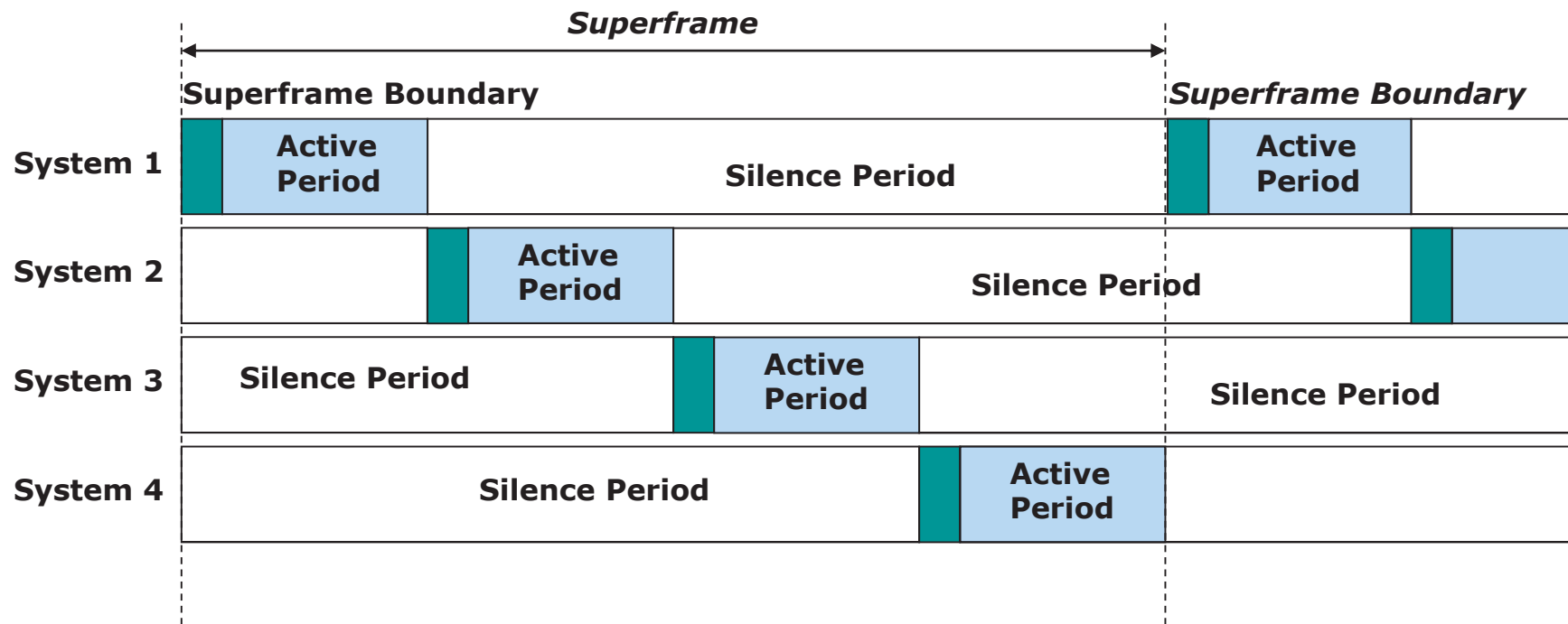


RECOMMENDATION: Utilization of orthogonal time-sliced sharing / coordination for resolution of co-channel interference in multi-tenant or building-building PALs or GAA due to overlap situations.

FCC 13-144 NPRM Technical Requirements for SAS Tier 2 Interference Management

An SAS to dynamically manage frequency assignments and automatically enforce access to the Priority Access and GAA tiers (4)

A Typical Enterprise Indoor/Outdoor Overlap Situation (Ethernet / 802.11 Distribution System Example)



RECOMMENDATION: The key regulatory challenge will be to specify the number of simultaneously overlapping Systems permitted (i.e., must be managed via the dynamic SAS process).

Emerging Small Cell Technologies Facilitating the Development of a Spectrum Sharing Ecosystem

Discussion

- ***Thank you for allowing the opportunity to discuss our views***
- ***Are there any other issues you would like us to consider?***
- ***Recommendations and next steps?***